

Wildland Urban Interface Fires

Hazard Reduction Research

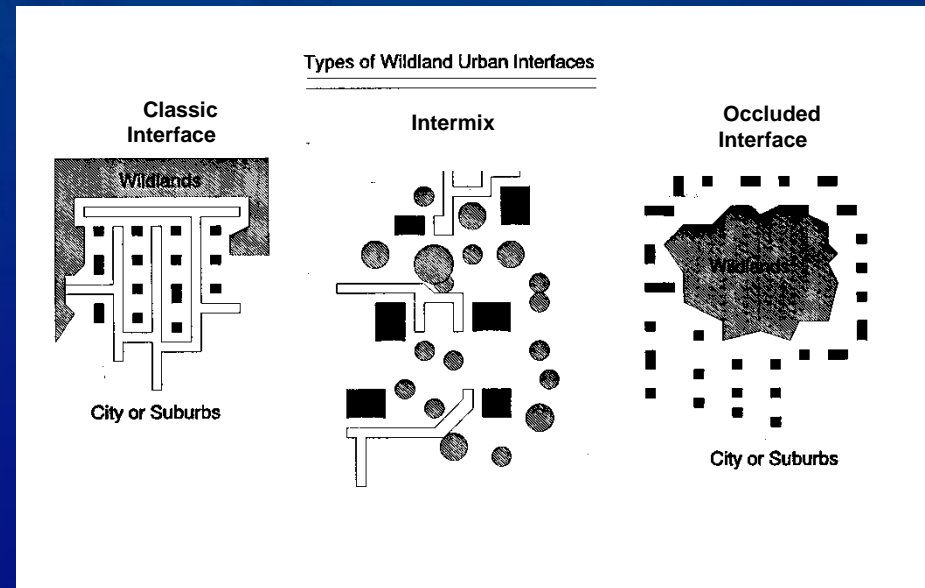
Paradise CA, August 2019

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“The Urban Wildland Interface community exists where humans and their development meet or intermix with wildland fuel.”

Federal Register
<https://www.gpo.gov/fdsys/pkg/FR-2001-01-04/html/01-52.htm>



Outline

1. NIST, Who We Are and What We Do
 2. The Camp Fire Timeline Reconstruction
 - Goals, Partners, Work to date
-
3. Wildland and WUI Fire Problems
 4. NIST WUI Fire Research – Field Studies, Experiments and Results
 - Witch, Amarillo, Waldo
 - Fences and Woodpiles
 5. Summary of Findings for Fences and Woodpiles



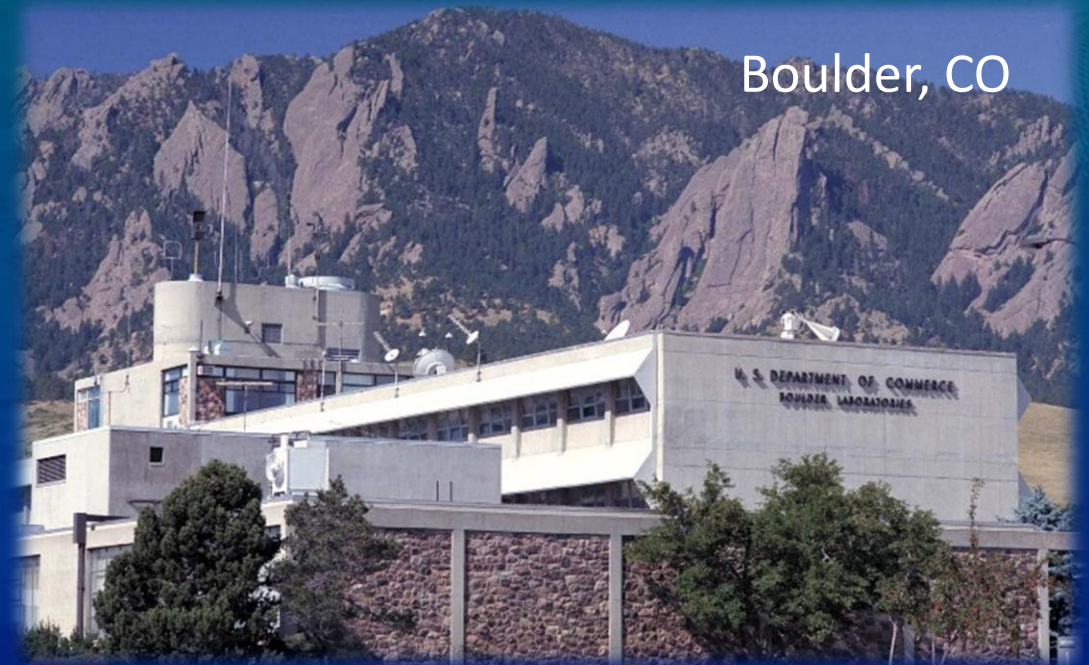
1. NIST, Who We Are and What We Do



National Institute of Standards and Technology (NIST)

US Federal Government Agency
Research Institute
Non-regulatory
Engineering Laboratory / Fire Research Division

Gaithersburg, MD (main campus)

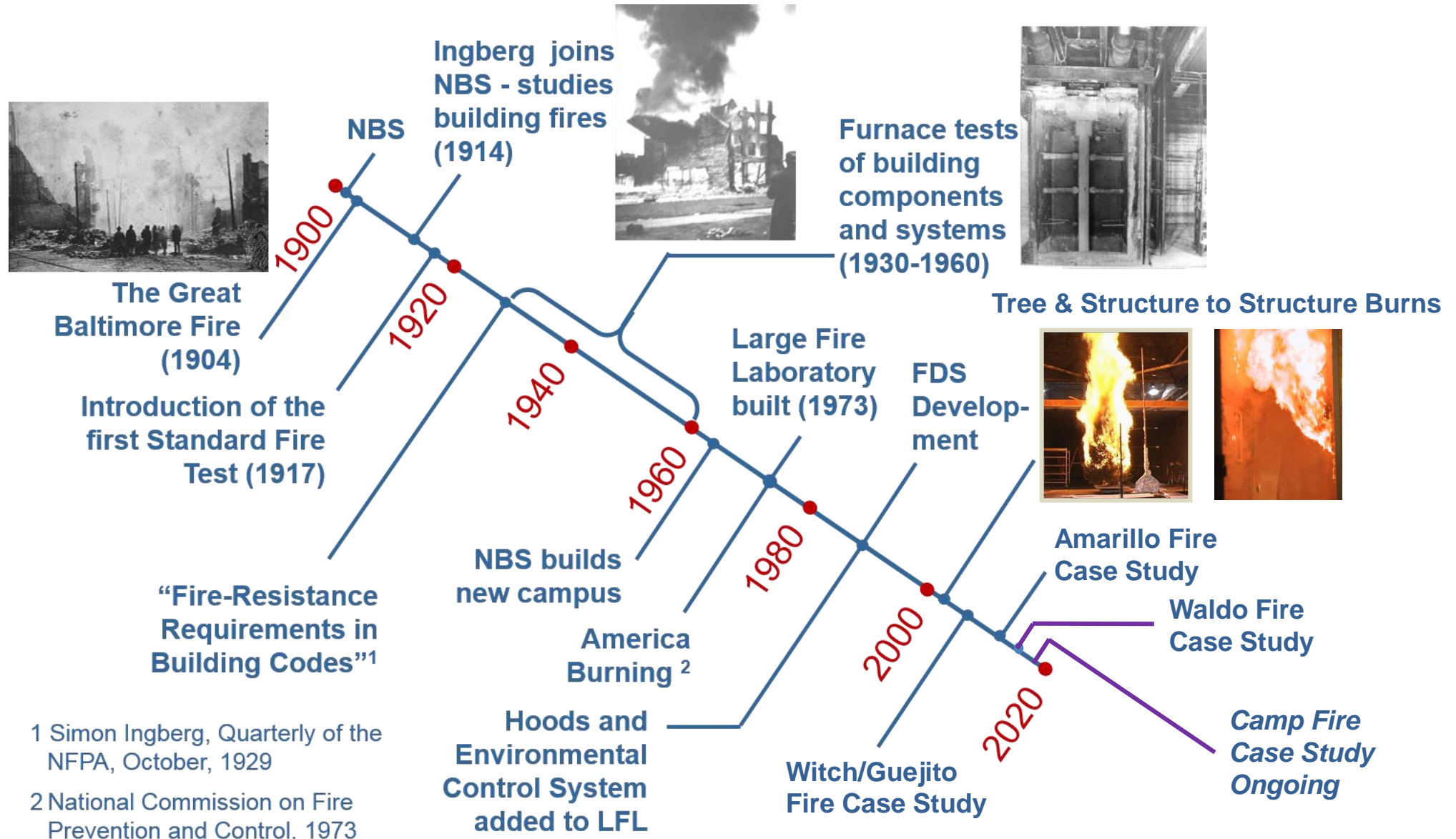


Boulder, CO

- 3,000 employees (1,800 scientists, engineers) + 3,500 associates on two primary campuses
- FY 2015 \$864 million in direct appropriations and \$170 from other sources

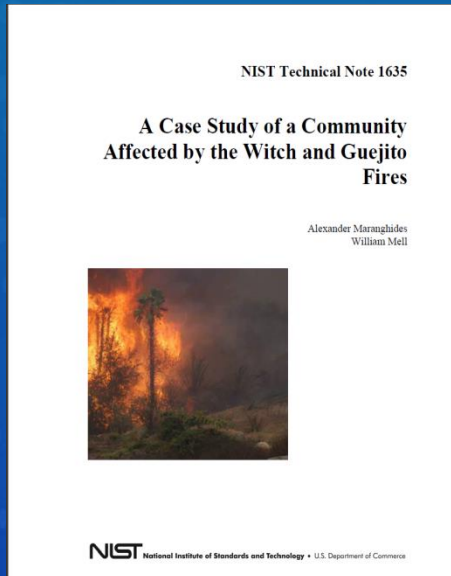


History of NIST Fire Research



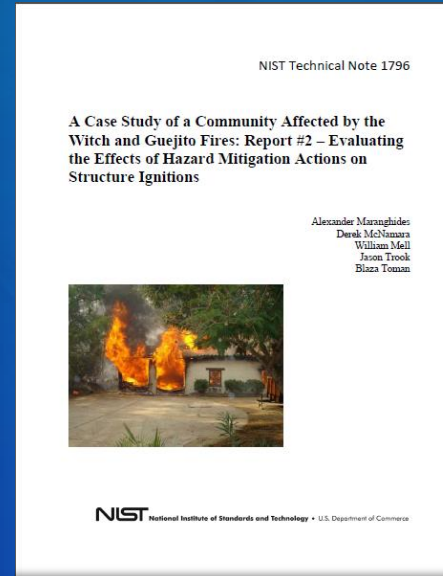
Published Case Studies and WUI Scale

NIST TN1635 (Witch #1)



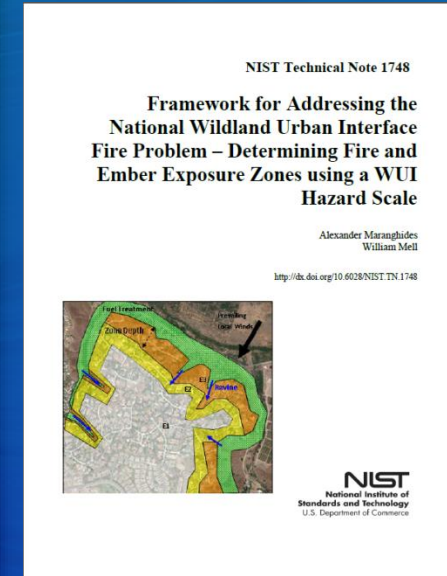
- Timeline reconstruction
- Defensive actions
- Structure ignitions
 - Roofs
 - Decks

NIST TN1796 (Witch #2)



- Exposure quantification
- Defensive actions
- Effectiveness of mitigation

NIST TN-1748 (WUI Exposure Scale)

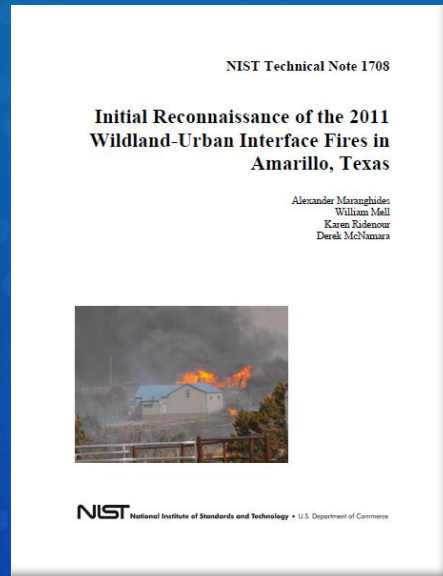


- Exposure scale framework
- Linking exposure to building construction through codes and standards



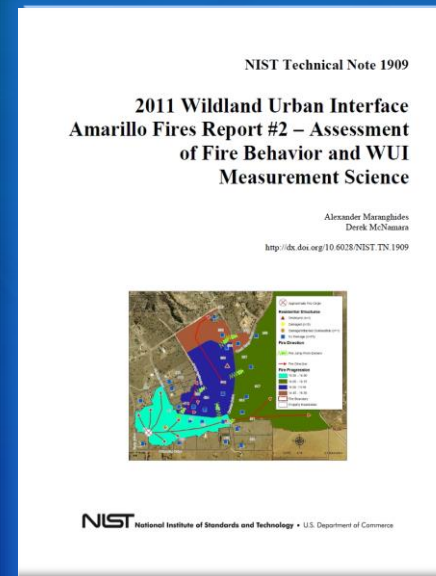
Published Case Studies and WUI Scale

NIST TN1708 (Amarillo #1)



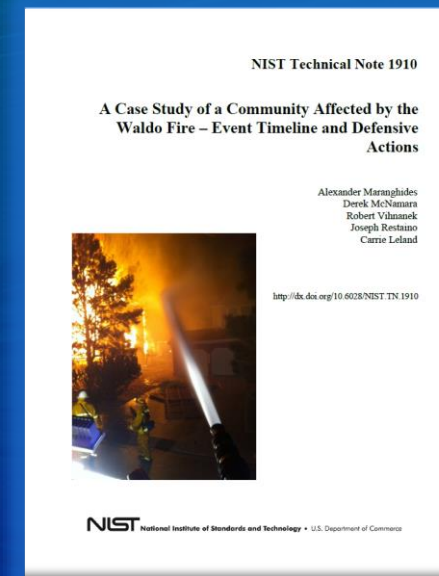
- Deployment methodologies
- Damage Assessment Summary

NIST TN 1909 (Amarillo #2)



- “Area/Neighborhood” Case Studies
- Fire Behavior
- Parcel Level Hazards:
 - Fences
 - Woodpiles
 - Retaining Walls

NIST TN 1910 (Waldo)



- Defensive Actions
- Timeline reconstruction
- Fire Behavior
- Response Time



2. The NIST Camp Fire Timeline Reconstruction

- Goals:
 - Timeline Reconstruction of the Camp Fire
 - Focus on first 24 hours of the fire
 - Document fire behavior, defensive actions, weather and evacuation and emergency notification
- NIST, USFS, FEMA Team was on scene within eight days of ignition
- Timeline Reconstruction effort is led by NIST
- Joint effort with CALFIRE, the USFS, FEMA, state and local jurisdictions including the Town of Paradise and Paradise Police Department



The NIST Camp Fire Timeline Reconstruction

- Work to date:
 - The Team has spent over three months collecting field data and technical discussions with first responders and other personnel
 - 140 Technical Discussions with Fire Response, Law Enforcement, Town of Paradise...
- Approximately ~95+% done with data collection
- Timeline report completion ~~ Spring 2020



The NIST Camp Fire Timeline Reconstruction

140 Technical Discussions

91 Fire Department



19 Law Enforcement

13 Transportation

8 Town of Paradise Officials/Employees

2 Water Districts

1 National Weather Service



3. Wildland and WUI Fires Problems

- Construction occurs in the WUI
- 46 million homes are currently in WUI across the US
- Annually 65,000 wildland fires
- 2-3 % of wildland fires spread into WUI communities

Hazard Reduction Options:




- Harden communities to better resist exposure to WUI fires
- Reduce Wildland Fire Exposures

Fire Protection Eng.:
✓ Hazard Reduction
for Indoor Fires

Building and Fire codes are an effective approach to
hardening structures/communities



WUI Fires Are Different

Urban Response	Urban Fire Extent of Damage	WUI Response	WUI Fire Extent of Damage	Wildfire Response	Wildland Fire Extent of Damage
One Fire Department Multiple Fire Stations	Room of origin  seconds to minutes	Multiple Fire Departments and Jurisdictions <u>Mutual Aid</u>	Interface boundary  minutes to hours	Multiple Land Owners and Jurisdictions <u>Mutual Aid</u>	100 acres  hours to days
	Floor of origin		Neighborhood		1,000 acres
	Building of origin		Community		10,000 acres
	Surrounding buildings		Part of City		100,000 acres
SOPs in place to work together across stations		Entire communities can burn in just hours		Time available to coordinate deployment	

Exposed structures often outnumber firefighting resources

Structures need to withstand exposure on their own



Fire Spread in the WUI

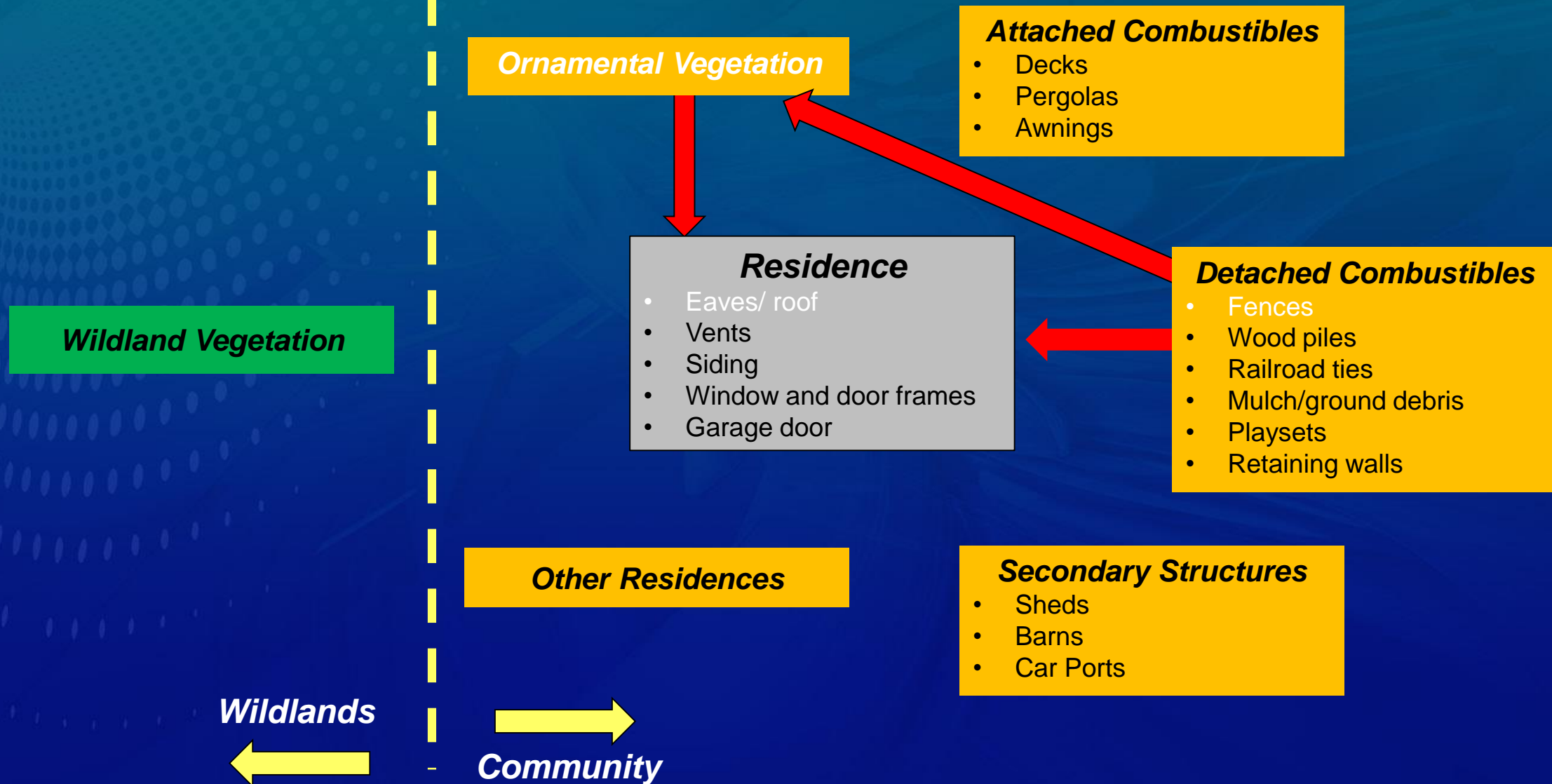
- Thermal radiation
- Flame contact
- Embers (or firebrands)



Photo courtesy of CALFIRE, used by permission



Fire and Ember Exposures to a WUI Residence



Fire Hazard Reduction in the WUI

- Reduce Exposure from Wildlands –
 - In many cases not at the control of the community as the land has a different owner.
 - \$\$, environmental, maintenance and performance issues.

➔ • Harden Community



Fire Hazard Reduction in the WUI

- WUI structures not hardened against ignitions from embers or direct flame



Waldo Fire, CO, Colorado Springs
Fire Department, Used by
Permission

CA Chapter 7a

Reduce WUI building ignitions:

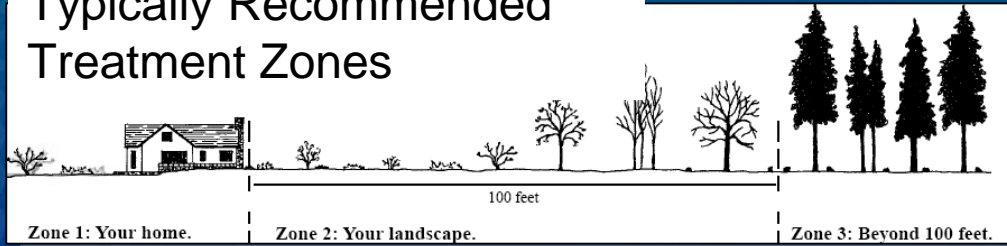
- Harden buildings: Existing stock of buildings is large and retrofit is very costly
- – Reduce exposure: every target is a potential exposure source



Different Types of High Hazard WUI – Different Solutions

✓ Low Density – FIREWISE

Typically Recommended Treatment Zones



10 structures/sq mile

Fuels Displacement works

High Density

100 ft radius



Housing density:
Circles illustrate inability of property owners to create 100 ft radius Treatment Zones on their properties

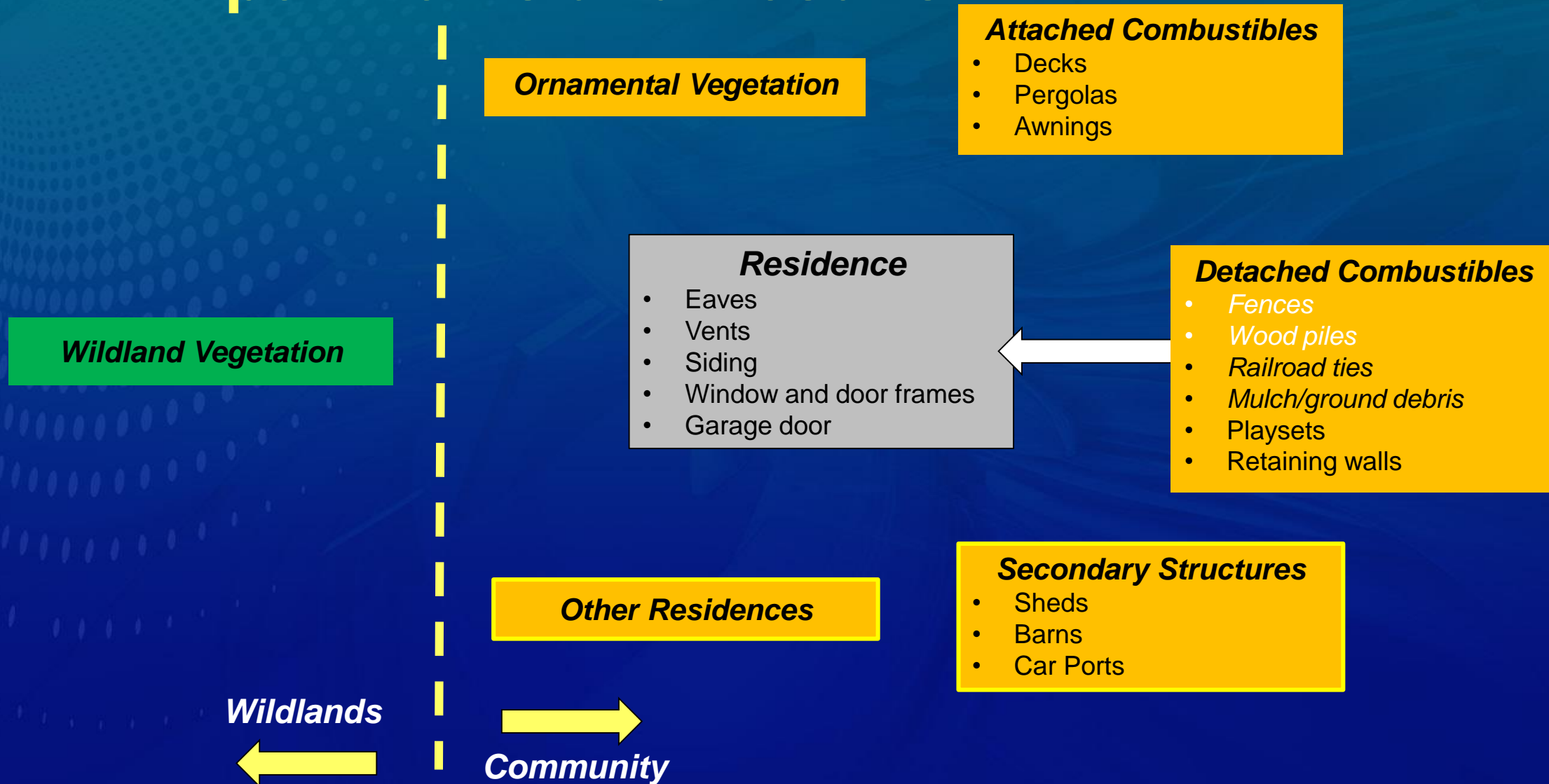


300 structures/sq mile

Fuels Removal is necessary



4. NIST WUI Fire Research – Field Studies, Experiments and Results



Fences - WUI Fire Hazard

- Contribute to fire spread:
 - Direct flame* contact with linear feature
 - Ember generation* throughout length of linear feature
- Fences can spread fire for long distances inside the community across multiple parcels
- Take away valuable resources from defending structures*



Waldo Fire, CO, Colorado Springs Fire Department, Used by Permission

* Also applies to other detached and attached combustibles



Fences in the WUI

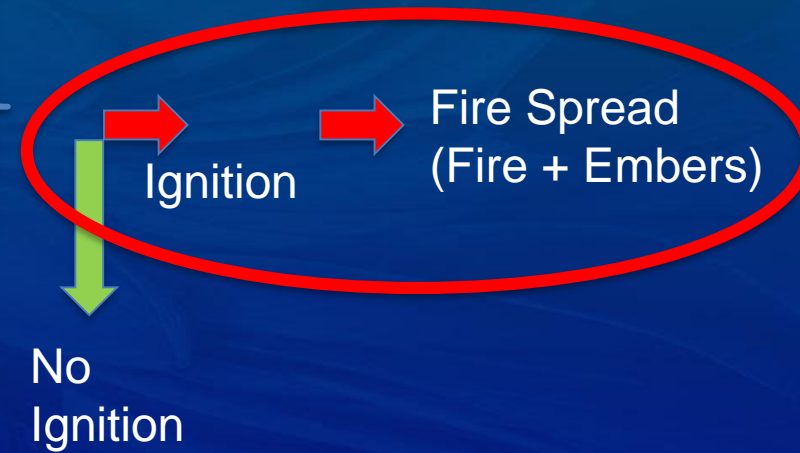
Exposure

- Fire/Embers
- Wind
- Slope

Fence

- Materials
- Design/Geometries
- Coatings/Treatments
- Age

Fire Behavior



Fences and Mulch

- 172 fence and mulch tests (2016-2018)

Fence Types



Privacy



Lattice



Vinyl



Good Neighbor

Mulch Types



Hardwood



Pine Bark



Pine Straw

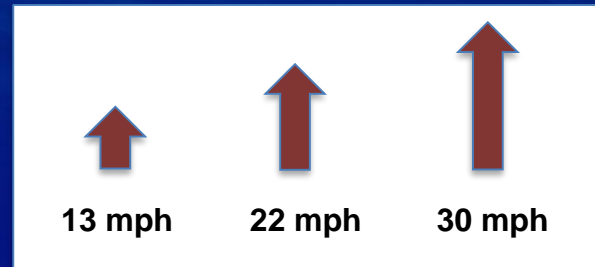


Rubber

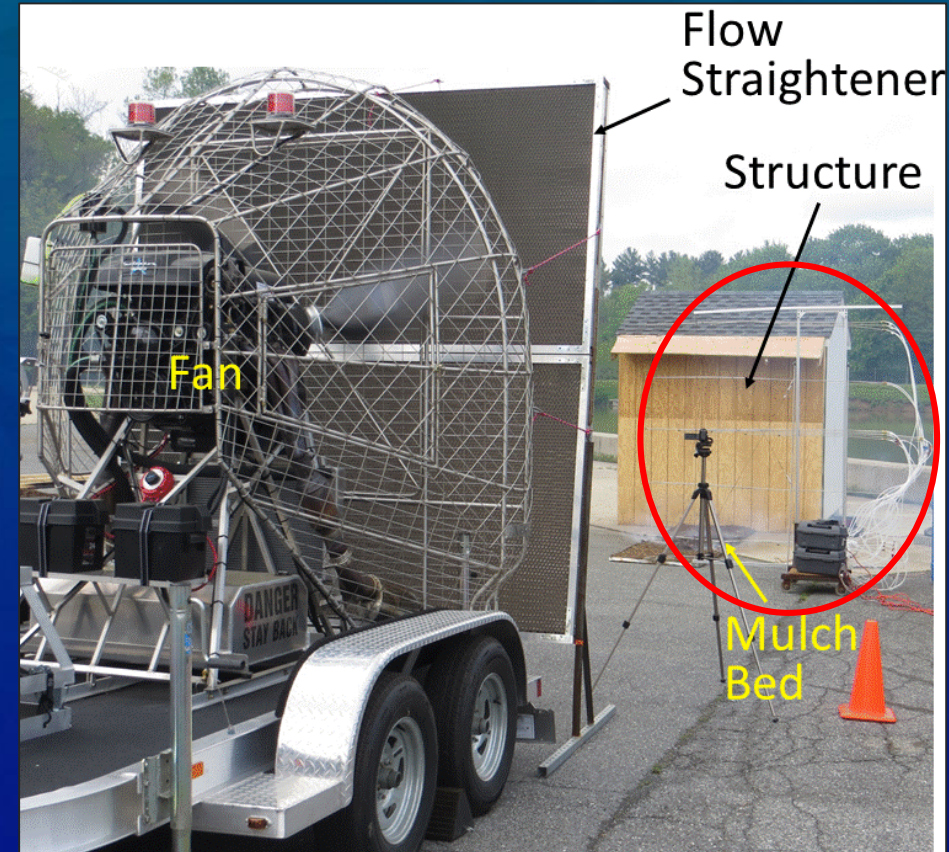
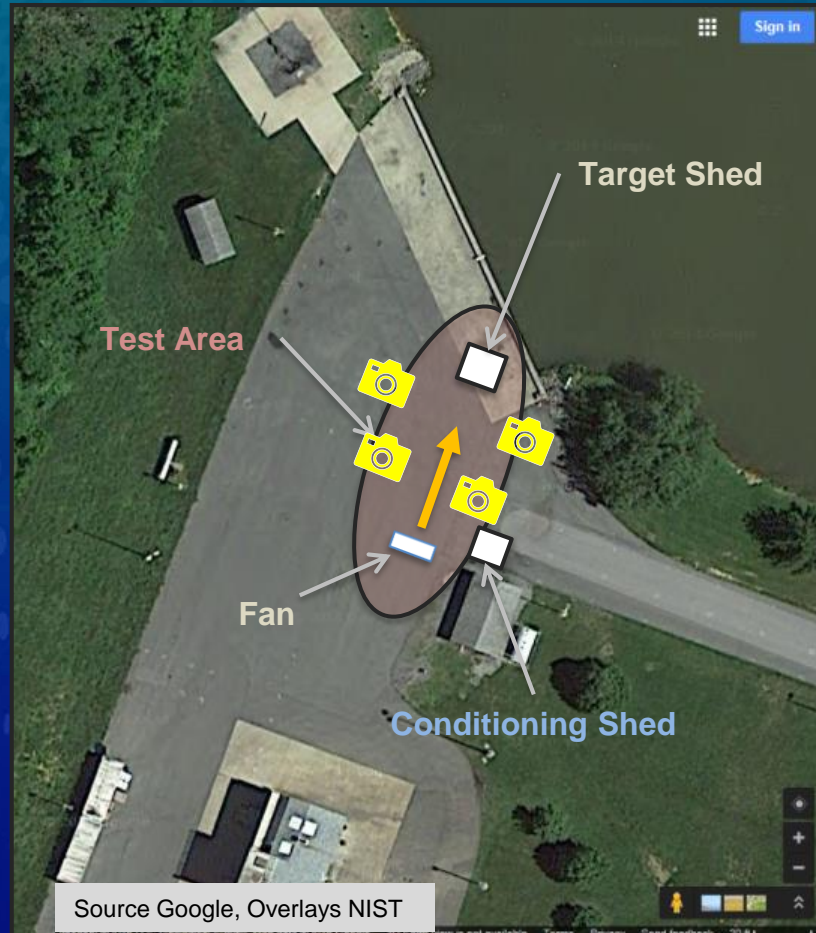
Separation Distance



Wind Speed



Experimental Setup



Frederick County MD Public Safety Training Center



Single Fence Experiment



Distance to shed = 1.8 m (6 ft)
Wind speed = 10 m/s (20 mph)



Single Fence (Wood Double Lattice and PVC) Experiments w/ mulch



Distance to shed = 6 ft (1.8 m)
Wind speed = 13 mph (6 m/s)



Distance to shed = 0 f (0 m)
Wind speed =20 mph (10 m/s)



Parallel Fences – A Different Scenario

- Frequently installed in parallel:
 - Increases fuel load
 - Potential radiation feedback
- Belong to different owners



Increasing the Spacing

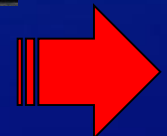


8 in

12 in

18 in

24 in



36 in

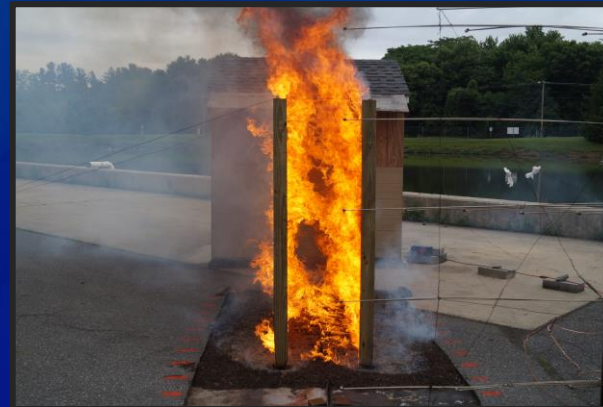
Combination of combustibles increase the hazard non-linearly



Parallel Fences + Mulch

- Fast Horizontal Fire Spread
 - 5-14 minute test duration
 - Non-linear growth
 - Flames above fence
- Fast spotting to shed

Distance to shed = 6 ft (1.8 m)
Wind speed = 13 mph (6 m/s)



Frederick Public Safety Training Center



Spotting and Ignition Potential - Experimental Setup and Results

Source Terms:

- Double lattice redwood fence
- Shredded hardwood mulch
- Maple Firewood

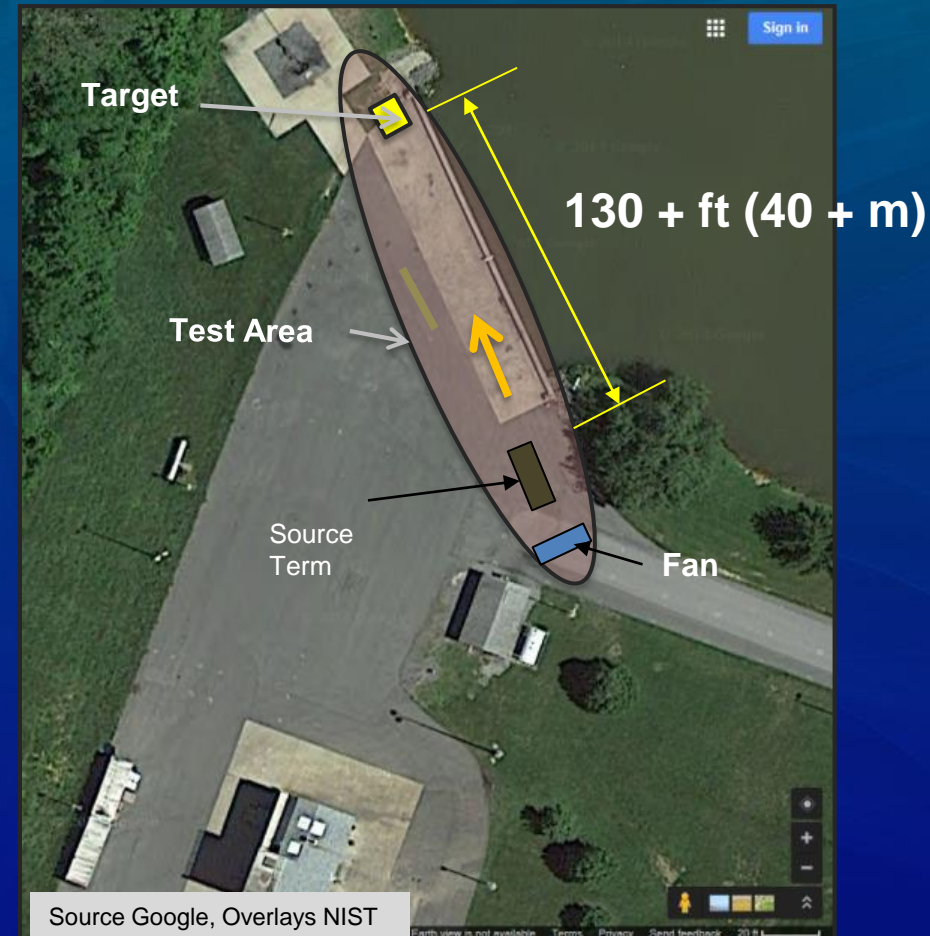
Targets:

Shredded hardwood mulch (on the ground and elevated)

Times to spotting: 55 sec. to 5 min.

Spotting Distance: 130+ ft (40+ meters)

Wind speed ~30 mph (13 m/sec)

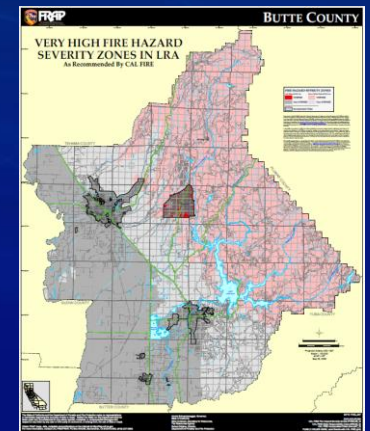


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Fences in High Hazard* and High Structure Density WUI

- Large energy release frequently attached to or within feet of structures
 - Enhance fire spread at a parcel level and between parcels
 - Contribute to other combustible ignitions (from sheds to vegetation to primary structures) from fire and/or embers
- ➔ – Can reduce occupant safety in scenarios with limited time to egress



Retaining walls and landscaping timbers– Ongoing research, similar results

* e.g.: CA Office of the State Fire Marshal, Very High Fire Hazard Severity Zone



Woodpiles and Other Detached Combustibles in High Hazard and High Structure Density WUI

- Exposed woodpiles:
 - can significantly enhance fire spread
 - can burn for a long time
 - NIST mitigation work is underway
- Combustible ground covers:
 - can significantly enhance fire spread –
 - can burn for a long time
 - frequently in the vicinity of other fuels (e.g.: vegetation, structures, fences)



Woodpile, less than 4 min. after ignition

Combinations of combustibles increase the hazard non-linearly



5. Summary of Findings for Fences and Woodpiles

- Fire Hazards in WUI
 - Combustible fences
 - Ground covers
 - Woodpiles
 - Combustible retaining walls
- Combinations of combustibles increase the hazard non-linearly

Paradise



Hazard Reduction Summary in High Hazard and High Structure Density WUI*

- Harden structures
- Reduce wildland fuel exposures
- Fewer combustible parcel level attributes can significantly reduce fire hazard in the WUI*
- Parcel level fuel removal may be necessary

* 130 + ft source to structure based on downwind ignition of combustibles from NIST experiments



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USFS

Thank You

www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305



Points to Remember

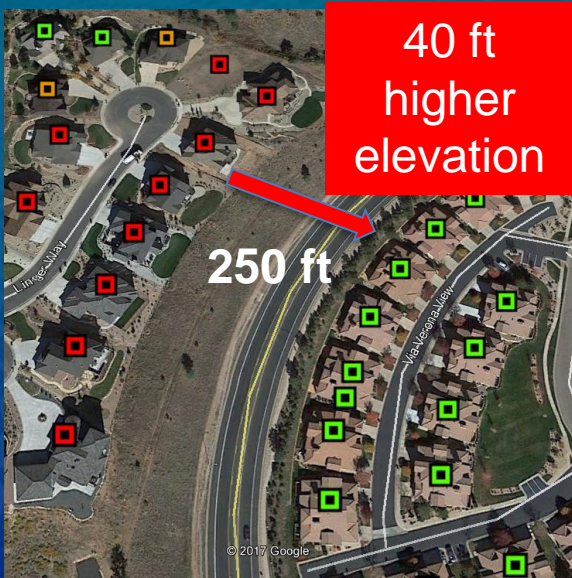
- Fire spreads by radiation/fire contact and embers (firebrands)
- Reducing parcel level combustibles reduces likelihood of structure ignition(s)
- You can affect your neighbors and your neighbors can affect you



Extra Material



Structural to Structure Fire Spread from Embers



Structure to Attached Combustible,
Waldo Fire



Structure to Roof,
Waldo Fire



Structures/Parcel to Fences,
Waldo Fire

2/3 of structure ignitions occur
directly or indirectly from embers
– Witch/Guejito Fires



Combustible Hazards Identified* in the Field

- Fences
- *Mulch*
- *Firewood*
- Railroad ties (used for retaining walls/ landscaping)
- Ornamental vegetation
- Other (playsets, outdoor furniture)

Tanglewood Complex Fire, TX, NIST TN1909

Table 12 Damage and destruction to linear features in Palisades South and selected portions of Lake Tanglewood Community.

Linear Feature	Meters Damaged	Meters Destroyed
Landscaping Border	37 (121 ft)	263 (863 ft)
Fence	2026 (6647 ft)	375 (1230 ft)
Retaining Wall	1014 (3327 ft)	563 (1847 ft)

* can also be attached or right next to structure.



High Hazard Building Attributes or Attached Combustibles

- Roof Systems (including roof coverings, attics, eaves and vents)
- Decks* (three ignition mechanisms): deck topside, deck underside, deck posts
- Garage doors
- Door and window frames (two different mechanisms)
 - Ignition of frame
 - Frame melting and window pane dropping out

* Decks can also be detached.



IMG_0633 NIST Image , Witch/Guejito - collapsed detached deck. Parcel was defended by first responders.



IMG_1628 NIST Image, Witch/Guejito - non collapsed detached deck. Parcel defended by first responders.



Experimental Setup with Fence



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